June 19, 1962 J. S. SENEY 3,040,153

YARN SPLICER

Filed Aug. 31, 1959 2 Sheets-Sheet 1

FIG. 1

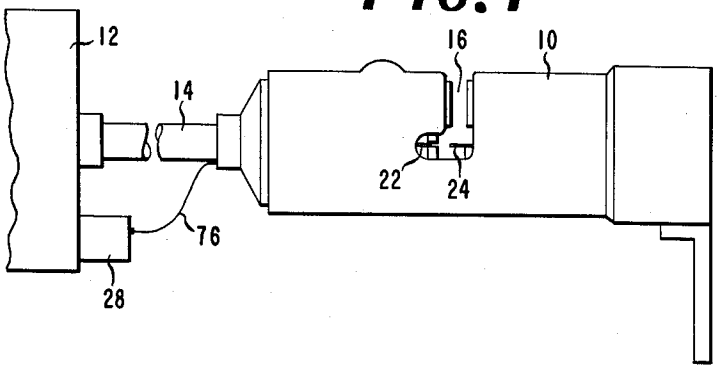


FIG. 2

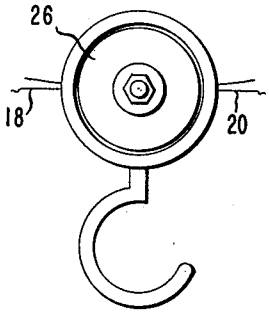


FIG. 4

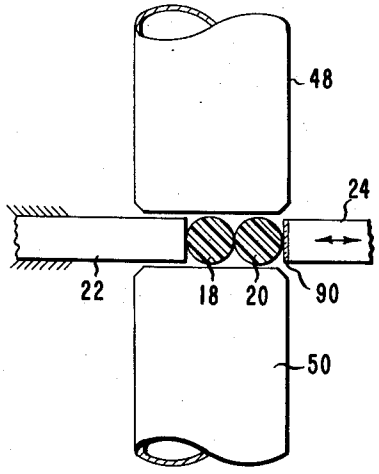
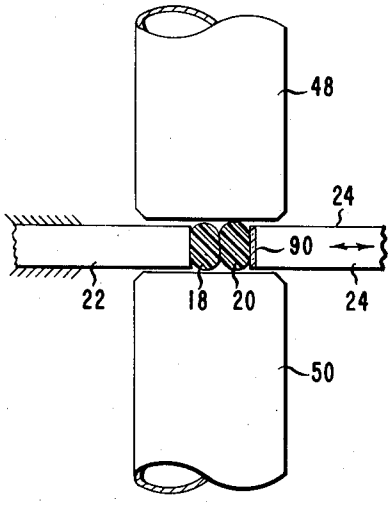


FIG. 5

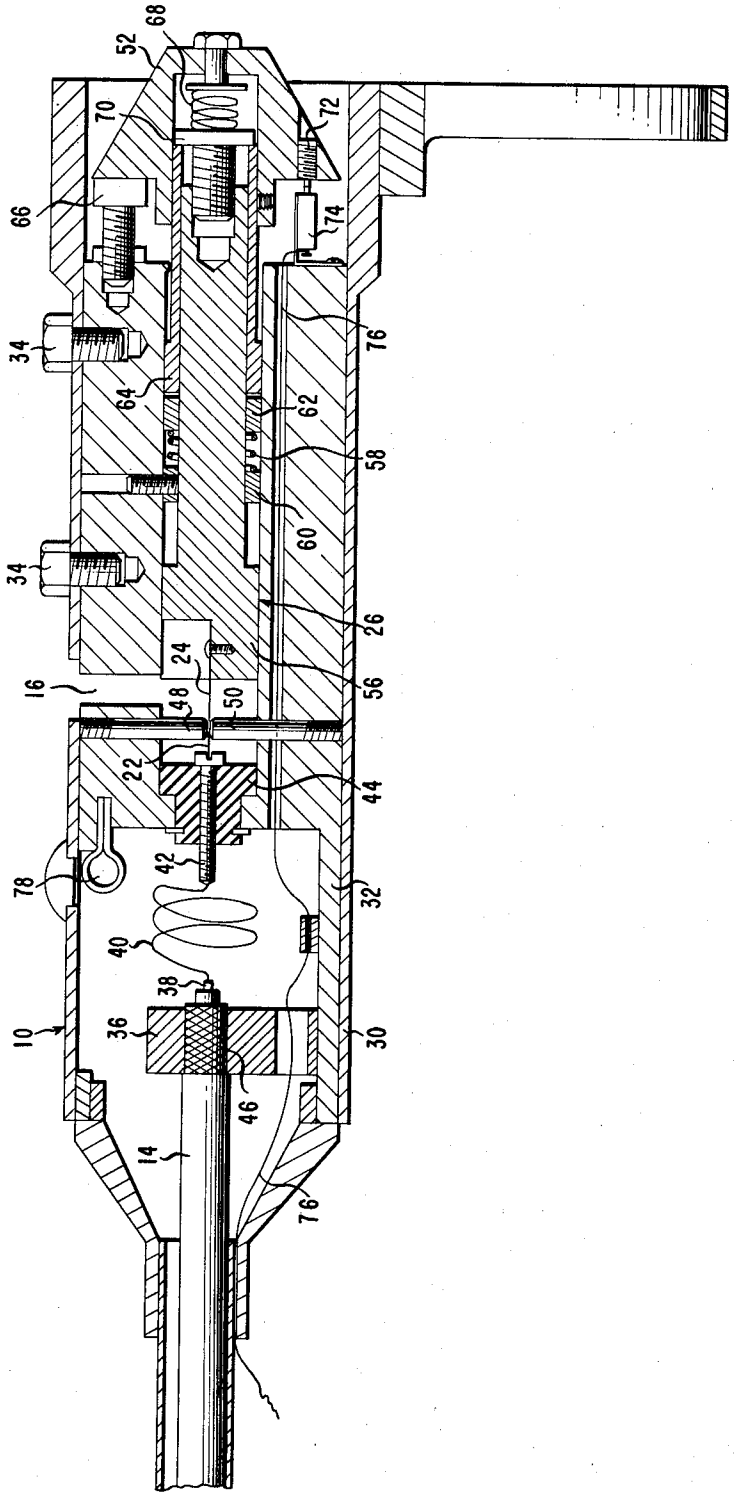


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FIG. 3



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YARN SPLICER

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This invention relates generally to the production of textile fibers and, more particularly, to an apparatus useful in joining yarn ends to provide a continuous structure.

The known practice in joining continuous filament or spun staple yarn ends is to tie the ends together in some form of a knot. In addition to the fact that these knots have an adverse effect on the end product, they lead to inefficiency in the operation of process equipment, especially in those recently developed processes where the joined yarn ends must pass through restricted orifices.

It is accordingly the general objective of the present invention to provide an apparatus for splicing overlapped thermoplastic yarn ends effectively and without appreciably increasing the yarn diameter.

The most important object of the present invention is to provide an improved splicing apparatus having relatively movable electrodes which are spring biased to exert a pressure on a pair of overlapped yarn ends as radio frequency energy is applied thereto.

Another important object is the provision of pins for confining the yarn ends in the splice region which pins are made of a material having a low dielectric constant so as to facilitate a more efficient use of the radio frequency power.

A further object is to provide a yarn-splicing apparatus in which the amount of high frequency power to be applied to a pair of yarn ends is subject to accurate control.

It is also an object of the invention to provide an apparatus which will effect a splice between two yarn ends in a rapid and reliable manner so as to minimize production down time while the splice is being made.

Additional objectives of the present invention include the provision of a switch which is actuated automatically by the movement of one of the electrodes for the purpose of initiating the splicing operation, the provision of a stroke length adjustment for the moving electrode, and the provision of a tunable component in the load circuit so as to permit variations of the circuit characteristics for yarn ends of different size and material.

With these and other objects in view, the yarn-splicing apparatus presented herein is a hand tool which has a support for a pair of spaced pins between which a pair of overlapped yarn ends are positioned for splicing. A fixed electrode extends into the space whereas a second electrode is movable into the space after the yarn ends have been positioned therein. The second electrode is mounted on a plunger which is slidable relative to the support and normally biased away from the fixed electrode. The electrodes are in a radio frequency load circuit which is energized responsive to movement of the plunger and the second electrode into the splice region.

Other objectives will become apparent in the following specification wherein reference is made by the use of designating numerals to the accompanying drawings in which:

FIGURE 1 is a side view of the yarn-splicing apparatus of the present invention;

FIG. 2 is an end view of the apparatus shown in FIG. 1;

FIG. 3 is a longitudinal section through the yarn-splicing apparatus;

FIG. 4 is an enlargement of the splice region, showing

a pair of overlapped yarn ends and the position of the electrodes just prior to initiation of the splicing cycle; and

FIG. 5 is a similar enlargement, showing the relative position of the parts at the end of the splicing cycle.

The thermoplastic materials employed in spinning synthetic yarns are poor heat conductors and it is therefore difficult to raise the inner portions to the proper temperature for effecting a splice without subjecting the surface layers to excessive temperatures. In the practice of the present invention, splicing is accomplished by overlapping two thermoplastic yarn ends on an anvil which is also one electrode of a pretuned high frequency circuit. The overlapped ends are pressed together by a second movable electrode. Movement of the second electrode toward the first electrode energizes the load circuit through the thermoplastic material with the result that sufficient heat is generated to soften the surface of the yarns thereby changing the capacitance characteristics of the circuit. This change is characteristics automatically detunes the circuit so that heat is no longer induced in the yarns while, at the same time, pressure is maintained on the overlapped ends until the splice has set.

In the embodiment chosen for illustration, the apparatus includes a hand tool **10** which is coupled to a radio frequency oscillator **12** through a coaxial cable **14**, as shown in FIGS. 1 and 3. There is an opening **16** in the casing of hand tool **10**, through which a pair of overlapped yarn ends **18**, **20** are threaded into position between electrodes **22**, **24**. Electrode **24** is moved toward fixed electrode **22** by a slidable plunger **26**. As the plunger **26** moves, a switch is actuated to energize the oscillator **12** through a timing device **28** which regulates the duration of the splicing cycle.

The hand tool **10** is shown in detail in FIG. 3 wherein it is seen that the operating parts are enclosed in a tubular casing **30**. Within casing **30**, a support block **32** is positioned by fasteners **34**. The coaxial cable **14** passes through one end of casing **30** wherein it is terminally supported in a clamp **36**. Cable **14** has an inner lead **38** which is connected through a load coil **40** to a mounting screw **42** for fixed electrode **22**. Screw **42** is positioned relative to support **32** by an insulating bushing **44**. The shield **46** of cable **14** is grounded through clamp **36**. The terminal end of electrode **22** blocks off the space between a pair of pins **48**, **50** which are arranged in end-to-end relationship. Thus, there is presented a confined splicing region into which overlapped yarn ends **18**, **20** may be threaded through opening **16**.

The preferred material for pins **48**, **50** is agate. A tetrafluoroethylene resin or other suitable material having a low dielectric constant may also be employed. Agate has a dielectric constant of 3.5–3.7 and a thermal conductivity in the same range as that of the thermoplastic material being spiced. Since the impedance of agate is substantially the same as that for air, only on extremely minute amount of energy will be expended by a flow of current through pins **48**, **50** and substantially all of the power delivered to the electrodes will be utilized in heating the yarn ends in the splice region.

When the yarn ends **18**, **20** are in position, electrode **24** is moved toward electrode **22** and into the space between pins **48**, **50** by pressure applied to a button **52** on the plunger **26** on which electrode **24** is mounted. Plunger **26** is comprised of two relatively movable sections, one of which includes the button **52**, the other of which is designated **56** in FIG. 3. Plunger **26** is normally biased away from the splice region by a spring **58** which acts between a fixed stop **60** and a stop **62** on section **56**. Section **52** of plunger **26** also includes a sleeve **64** which is telescoped over section **56**. The stroke of the plunger is limited by the engagement of section **52** with a stop **66**, with the mo-

tion of button 52 being transmitted to section 56 through a pre-set tension spring 68 which engages a stroke length-adjusting screw 70.

Movement of button 52 into engagement with stop 66 also causes a plunger 72 to close the normally open contacts of a switch 74 which is coupled to timing device 28 through a two wire lead 76. Actuation of switch 74 and timer 28 energizes radio frequency oscillator 12 which is the source of power for the load circuit, i.e., for load coil 40 and spaced electrodes 22, 24. In view of the low dielectric constant of the material from which pins 48, 50 are made, they serve to focus the high frequency field on the yarn ends being spliced.

The apparatus disclosed herein is placed in operation by locating overlapped yarn ends 18, 20 between pins 48, 50 and against fixed electrode 22. Button 52 is then depressed until it engages stop 66 and closes switch 74. Force is exerted through tension spring 68 and the head of screw 70 to move the electrode 24 into the space between pins 48, 50 in confining relationship to yarn ends 18, 20. Line voltage is applied to oscillator 12 through timer 28 to produce radio frequency power between electrodes 22, 24. As heat is applied thereto, the yarn softens and electrode 24 continues to descend by action of the substantially constant pressure from spring 68 until such time as the head of screw 70 strikes the end of sleeve 64. This prevents further motion of the moving electrode and gives the splice a definite thickness dimension. When 1020 denier yarn is being spliced, the force applied is approximately 600 lbs. per square inch and the cross sectional area of the resulting splice is smaller than the sum of the areas of the two individual yarn ends.

The cycle must be long enough to allow the abutting surfaces of the yarn ends to soften and weld but must be terminated before the melting point of the yarn is reached. If the timing is not so adjusted, crystallization may occur because of the excessive heat applied to the thermoplastic materials. The elapsed time of a splicing cycle should be in the order of two seconds. When the cycle has been completed, the line voltage is automatically removed from the oscillator by timing device 28. The best splice is obtained when maximum heat is applied at a point midway in the cycle. Maximum heat is achieved when the inductance and capacitance components are equal, i.e., when the load circuit is at resonance. The inductance component is mainly dependent on the load coil 40 whereas the capacitance component depends on the spacing between the electrodes. As the splicing cycle progresses, the electrodes move together with a corresponding increase in the capacitance component. Accordingly, the point of maximum heat application may be adjusted by effecting a change in the inductance component. This is accomplished by changing the geometry of load coil 40 so that the ratio of the capacitance component to the inductance component of the load impedance is unity at the desired point in the cycle.

In some instances, it may be desirable to make the splicing apparatus self-regulating rather than dependent on the timing device 28. Since the capacitance component increases as the electrodes move together, the ratio of capacitance to inductance components may be varied, as discussed above, to deliver the maximum energy in the desired time relationship to the energization of oscillator 12 by switch 74. There are then three periods during the splicing cycle, namely, the initial or preheat period where the inductance component exceeds the capacitance component, the maximum heat period where the load circuit is at resonance, and the post heat period which is terminated when the circuit becomes detuned.

Further control is accomplished by having a neon bulb 78 inductively coupled to the load coil 40 so that when power is applied to the circuit, the bulb is energized. The ionization voltage of the bulb is such that it will be energized as power is applied to the load circuit, becomes brighter as resonance is approached, and dim during the post heat period. It thus gives an indication to the operator of the time when the splicing cycle is completed and button 52 may be released.

It is preferred that electrodes 22, 24 be made of metal, although some materials commonly though to be non-conductors will transmit radio frequency currents. Where the lesser deniers are being spliced and screw 70 is accordingly turned to extend the length of section 56, there is a tendency for arcing to occur between the electrodes. This can be overcome by placing a low impedance tip 90 (FIGS. 4 and 5) on the end of one or both of the electrodes. One suitable material for the tips is aluminum oxide (synthetic sapphire or ruby).

In addition to the fact that the splices resulting from the practice of this invention have a minimum cross sectional area, there are other advantages, e.g., the splices are free of adhesive or solvent and have greater strength than those which depend entirely on adhesive forces. It has been found that the resulting splices have a tensile strength equal to or greater than the strength of undrawn yarn.

It is apparent that many changes and modifications may be made in the disclosed yarn-splicing apparatus without departing from the spirit of the present invention which is therefore intended to be limited only by the scope of the appended claims.

I claim:

1. A yarn-splicing apparatus comprising: a unitary support; a pair of pins arranged in end-to-end spaced relationship; a fixed electrode extending into the space between said pins to present an anvil against which a pair of overlapped yarn ends may be positioned, said pins and said fixed electrode being mounted on said support; a plunger including first and second telescoped sections, first spring means biasing the sections apart and stop means limiting the extent of telescoping movement responsive to the action of said first spring means, there being a second electrode on said second section, the latter being axially, slidably mounted on the support for movement of the second electrode toward and away from a position in which it extends into said space in opposed relationship to said first electrode; second spring means positioned between said second section and the support for normally biasing the second section away from said position; second stop means on said support, within the path of travel of said first section, for limiting its movement toward said fixed electrode; a circuit for energizing the electrodes; and switch means within the path of travel of said plunger toward said position for energizing said circuit.

2. The yarn-splicing apparatus of claim 1 wherein said circuit includes a high frequency power source, a load inductance and said electrodes, the space and yarn ends between said electrodes providing a load capacitance.

3. The yarn-splicing apparatus of claim 2 wherein the load inductance is a coil and wherein the splicing cycle may be adjusted by altering the configuration of the coil.

4. The yarn-splicing apparatus of claim 2 wherein timing means is coupled with said switch means for limiting the splicing cycle.

5. The yarn-splicing apparatus of claim 2 wherein at least one of said electrodes is provided with a low impedance tip whereby to prevent arcing.

6. The yarn-splicing apparatus of claim 2 wherein said pins are of agate and have a dielectric constant of from 3.5–3.7.

7. The yarn-splicing apparatus of claim 2 wherein said pins are of a tetrafluoroethylene resin.

8. In a yarn-splicing apparatus including a support, a first electrode fixed on the support, a second electrode and a source of radio frequency power coupled to the electrodes: means mounting the second electrode on the support for movement toward and away from the fixed electrode, said mounting means comprising a plunger slidable relative to the support and resilient means positioned between the plunger and the support for biasing the plunger away from the fixed electrode, said plunger including first

and second relatively slidable sections, said second electrode being mounted on said second section, said first section having a tubular extension telescoped on said second section, the latter having a screw extending from its telescoped end and there being a coil spring located within said first section in engagement with said screw, said extension being within the path of travel of said screw, thus limiting the action of said coil spring, said support being provided with stop means limiting the movement of said first section toward said fixed electrode.

References Cited in the file of this patent

UNITED STATES PATENTS

2,514,184	Lower	July 4, 1950
2,514,197	Groten et al.	July 4, 1950
2,569,968	Autie et al.	Oct. 2, 1951
2,609,480	Snyder	Sept. 2, 1952
2,634,363	Hacklander et al.	Apr. 7, 1953